Italian Seismic Bulletin 2008

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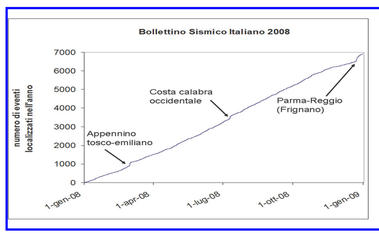
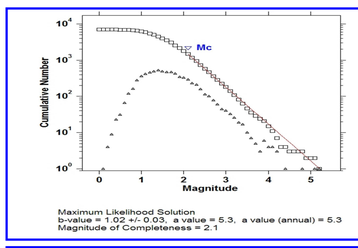
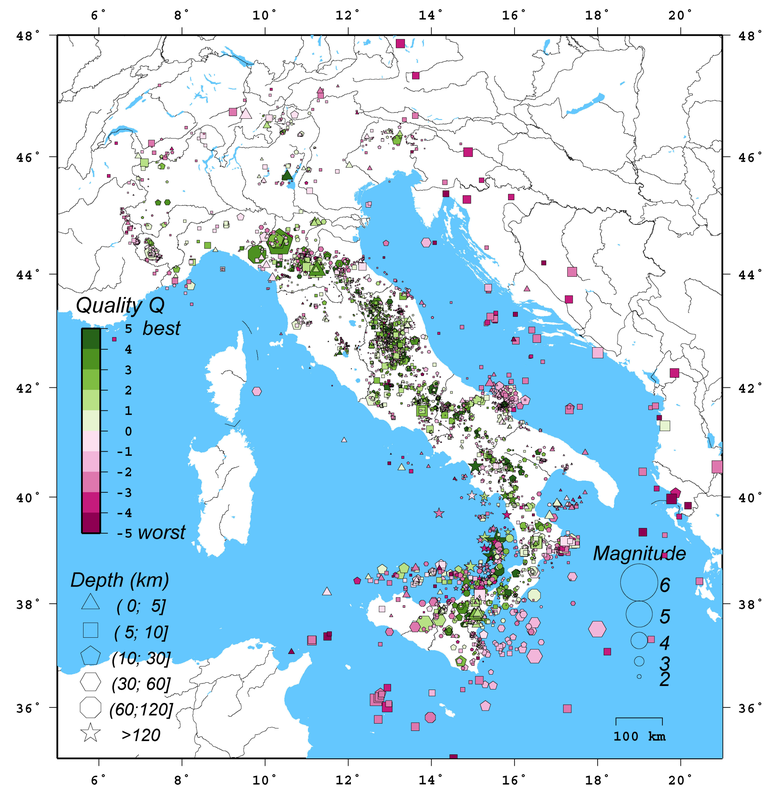
During 2008 the Italian National Seismic Network localized 6969 events in Italy and neighboring areas, with an apparent minimum magnitude of completeness ML 2.1. The Italian Seismic Bulletin 2008 used signals from 279 stations belonging to INGV and to other local and regional networks, all with real-time connection to the Centro Nazionale Terremoti in Rome. We illustrate evidences that confirm the presence of a certain percentage of events due to anthropic activities (explosions), erroneously interpreted as earthquakes of low magnitude. We identify 14 areas with explosions in quarries with surface mining activity.



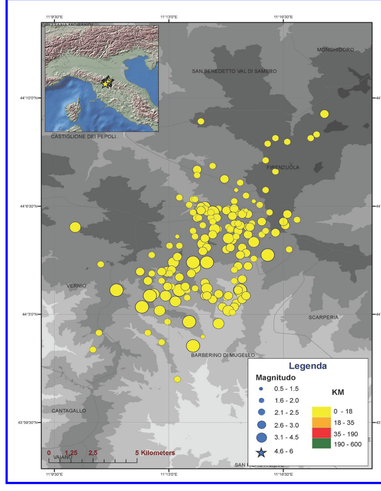
Cumulative number of events located during 2008. It is possible to recognize the presence of three main seismic sequences with the maximum number of earthquakes in few days, that struck the Toscana-Emilia Apennine (Mugello) in March, the north-western Calabria (Sant'Eufemia Vetere) in July and the Parma-Reggio area (Frignano) in December.



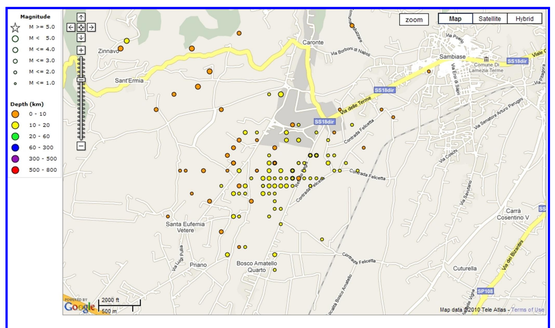
Cumulative (squares) and non-cumulative (triangles) Gutenberg-Richter distribution of the Italian Seismic Bulletin 2008. With the software *ZMAP* [Wiemer, 2001] we computed b = 1.02 +/- 0.03, a = 5.3 and Minimum Magnitude of Completeness Mc = 2.1. (see the following on the presence of quarry blasts in the bulletin).



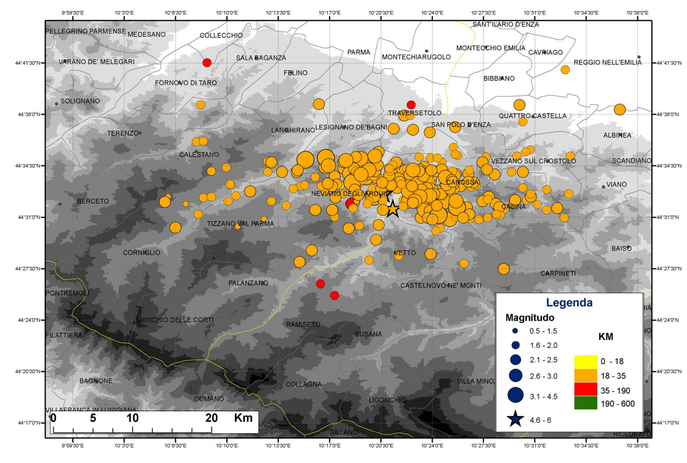
Map of the events recorded during 2008 in Italy. The size, color and shape of the symbols indicate the magnitude, location-quality and depth of the events, respectively. A large majority of earthquakes has a good location-quality in the peninsula. Events with poor location-quality can be found in sea areas, in the Gargano peninsula, in western Sicily and in the bordering Alpine belt.



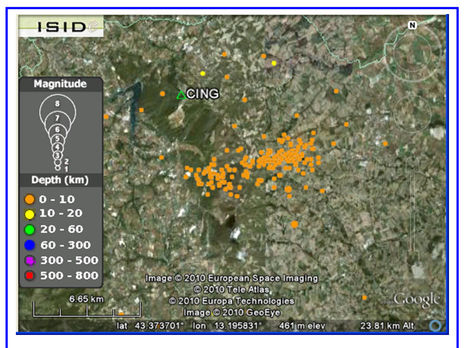
A seismic sequence started on March 1st 2008 in the Toscana-Emilia Apennine, between the provinces of Firenze, Prato and Bologna. During one morning 3 earthquakes occurred at 7:43, 8:43 and 10:43 UTC, of magnitude ML 4.4, 4.1 and 4.1 respectively.



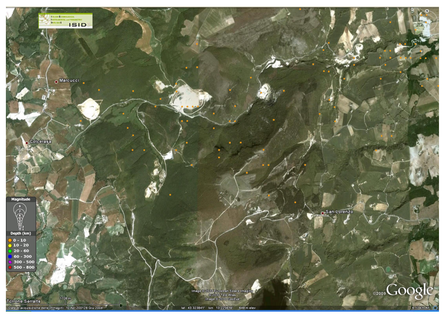
Map of the seismic sequence between Sant'Eufemia Vetere and Sambiase (Lamezia Terme) started on July 9th 2008, obtained with the utility *gmaps* in http://ISIDe.rm.ingv.it/. Main shock: ML 3.5 (July 10 2008, 12:50 UTC).

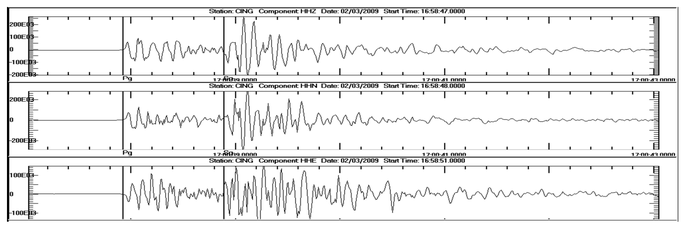


Seismic sequence in the Frignano area (near Reggio nell'Emilia), started on December 23rd 2008. The largest earthquake (15:24 UTC), of magnitude ML 5.2 (Mw 5.4 *Mednet Quick RCMT*), had a depth of about 23 km. It was followed in the same day by two events of ML 4.8 (Mw 4.9) at 21:58 UTC and ML 4 at 23:37 UTC. The sequence generated more than 300 earthquakes in three weeks.



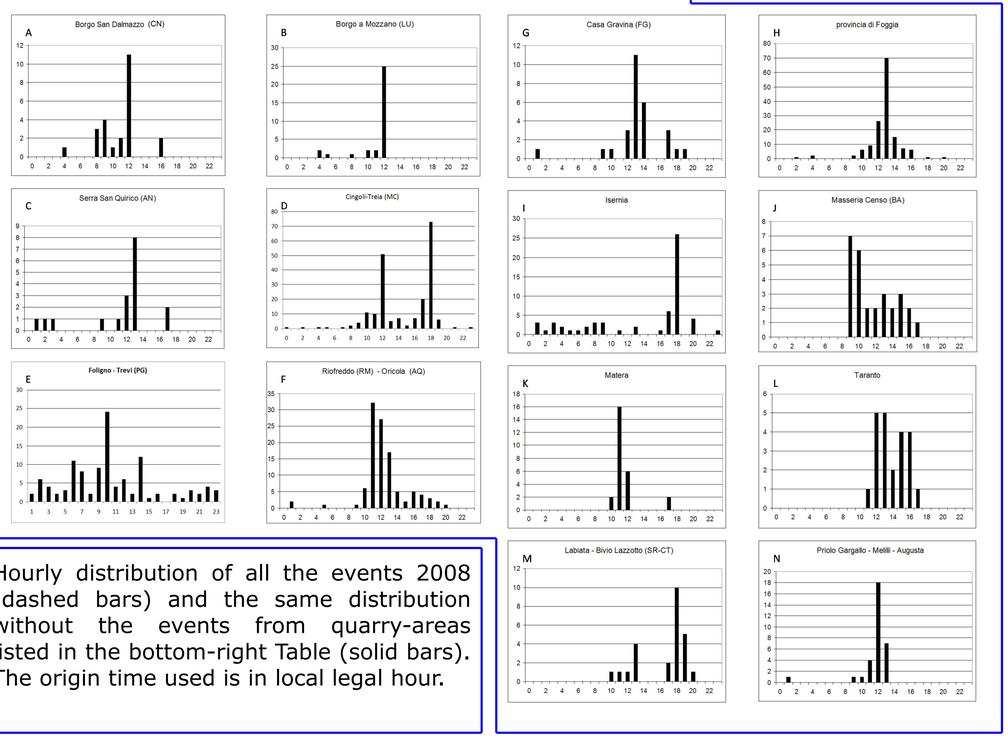
Quarry blasts and earthquakes recorded between Cingoli and Treia, in the province of Macerata, during 2008. The green triangle shows the position of a seismic station close to Cingoli (CING). The group of events at the center of the picture coincides with a series of quarries between Marcucci (Cingoli) and San Lorenzo (Treia) in the province of Macerata (a detail is shown in the figure below).

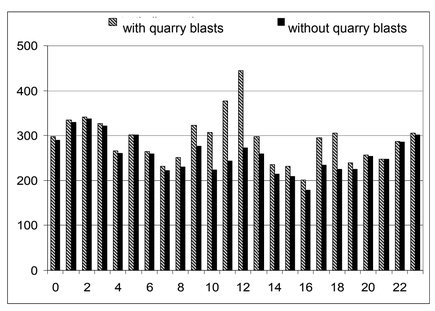




Explosion from a quarry near Cingoli (province of Macerata). Secondary phases generated by blasts are due to surface waves, but are sometimes interpreted as *Sg*. This misinterpretation leads the location process to an erroneously deeper hypocenter.

Hourly distribution of events located in quarry areas, identified analyzing the entire *Bollettino Sismico Italiano 2008* (BSI) (except for G and J reporting data from longer periods of time). We find an extremely reduced activity in all areas during evening and night hours, if compared to diurnal activity.





Hourly distribution of all the events 2008 (dashed bars) and the same distribution without the events from quarry-areas listed in the bottom-right Table (solid bars). The origin time used is in local legal hour.

It is possible to reveal if a seismic catalogue in a limited area is contaminated by quarry-blasts, dividing the number of events that happened in light hours by the number of those happened in night hours. Wiemer and Baer [2000], defined the marker Rq as:
$Rq = (Nd / Nn) / (Ld / Ln)$ where Nd is the number of light-events, Nn is the number of night-events and Ld/Ln is a normalization factor that takes into account for the number of light hours Ld and the number of night hours Ln. The expected value of Rq is 1 in purely seismic areas, where we can make the hypotheses that the earthquakes are randomly distributed during the entire 24 hours. If Rq is clearly above 1, we can suspect the presence of quarries (explosions are generally made during light hours).

References
Wiemer, S., (2001). A software package to analyze seismicity: ZMAP, *Seismol. Res. Lett.*, **72,** 373-382.
Wiemer, S. and M. Baer, (2000). Mapping and Removing Quarry Blast Events from Seismicity Catalogs, *Bull. Seismol. Soc. Am.*, **90** (2), 525–530.

Limits of 14 areas with quarry blasts recorded during 2008, identified with *ZMAP*. More than 600 events in the *Bollettino Sismico Italiano* 2008 are likely to have anthropic origin.

	Geographic area	*Latitude range*	*Longitude range*
A	Borgo San Dalmazzo (CN)	44.20N : 44.35N	7.33E : 7.58E
B	Borgo a Mozzano (LU)	43.90N : 44.00N	10.42E : 10:63E
C	Serra San Quirico (AN)	43.38N : 43.46N	12.97E : 13.02E
D	Cingoli-Treia (MC)	43.28N : 43.36N	13.17E : 13.34E
E	Foligno-Trevi (PG)	42.87N : 42.94N	12.72E : 12.80E
F	Riofreddo-Oricola (RM-AQ)	41.97N : 42.11N	12.85E : 13.10E
G	Casa Gravina (FG)	41.67N : 41.75N	15.46E : 15.58E
H	Foggia (FG)	41.56N : 41.69N	15.57E : 15.73E
I	Isernia (IS)	41.54N : 41.62N	14.11E : 14.47E
J	Masseria Censo (BA)	40.87N : 40.96N	16.55E : 16.69E
K	Matera (MT)	40.64N : 40.72N	16.58E : 16.79E
L	Taranto (TA)	40.48N : 40.64N	17.13E : 17.47E
M	Catania (CT)	37.30N : 37.50N	14.87E : 15.08E
N	Melilli (SR)	37.10N : 37.30N	14.90E : 15.20E